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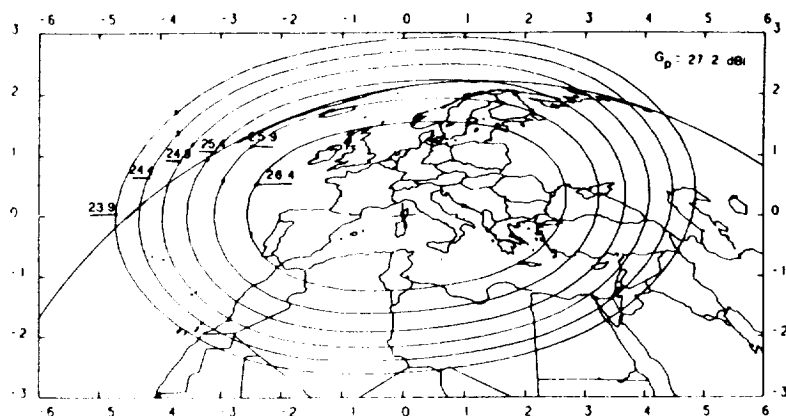


Fig. 2.2 EMS Antenna Isolevel Gain Curves

multipacting behaviour) is expected to be a determining factor for the feasibility of such advanced high power mobile systems.

Solid state L-band power amplifiers have been assessed, compared to TWTAs in terms of mass, efficiency, reliability, and finally chosen for the EMS transponder. At present, two L-band SSPA concepts are under developments in Europe: the DEBS, by MSS, and the PAMELA, by MBB. Both types have efficiencies of about 30%, at a C/I of about 18 dB under multicarrier operation (10 tone test), and low mass.

The forward and return channellized sections serve to multiplex and demultiplex the non-adjacent frequency slots available for the land mobile services. The forward repeater frequency plan shown in Fig. 2.3, consists of three non contiguous bands about 4 MHz wide.

The use of SAW filters will provide the necessary selectivity. A 120 MHz intermediate frequency is used.

Frequency coordination, with existing Ku-band Satellite Systems, requires, however, a more flexible return repeater multiplexing scheme. We slice each of the three non-adjacent frequency slots of Fig. 2.3 into three virtual channels (Fig. 2.4). The assignment of the return link channels may cope with any future spectrum utilization restraint. Nevertheless, fixed bandwidth filter multiplexers have a poor bandwidth utilization efficiency, due to the guardbands required in proximity of crossovers.

The AME company studied, under ESA contracts, a potentially attractive solution to this problem: the Bandwidth Switchable Saw Filter, or BSSF [5]. The device consists of a bank of phase matched SAW filters and a switchable combining network, with controlled phases. It is, thus, possible to combine any filter subset achieving a variable bandwidth filter. The outstanding advantage of the concept consists in the elimination of the guardbands at filters crossover, when using contiguous filters.

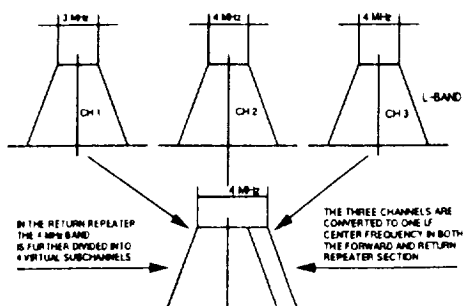


Fig. 2.3 EMS Forward Repeater Frequency Plan

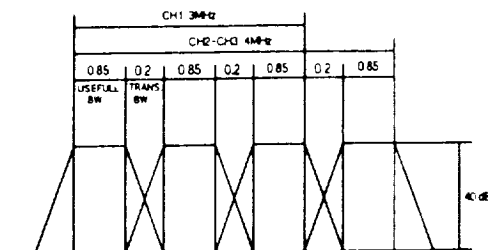


Fig. 2.4 EMS Return Repeater Frequency Plan

Table 2.1 EMS Payload Characteristics

- Coverage	Global European
- L Band EIRP	44.5 dBW
- L Band G/T	- 1.2 dB/K°
- Forward Useful Bandwidth	11 MHz total in three channels 4, 4. and 3 MHz wide
- Return Useful Bandwidth	9.35 MHz, in 11 channels 0.85 MHz wide each. May implement a BSSF combiner
- Ku-Band EIRP	34.9 dBW
- Ku-Band G/T	-1.4 dB/K°
- Payload mass including Ku-Band Feederlink	60 Kg.
- Payload DC Power including Ku-Band Feederlink	400 W

### 3. THE L-BAND LAND MOBILE PAYLOAD

#### 3.1 Mission Requirements

The L-band Land Mobile Payload must provide the same kind of service of EMS Payload, but with different coverage and EIRP requirements.

A spot beam coverage over Europe will be provided at high EIRP (+ 51 dBW) and G/T (+ 2.5 dB/K°) levels.

##### 3.1.1 LLM Payload Main Characteristics

The main performances of the LLM Payload are summarized in Table 3.1.

Europe will be covered both by a global coverage and by 6 spot beams as depicted in Fig. 3.1 and 3.2.

A steerable beam is available that can be moved over the positions shown in Fig. 3.3

The same frequency can be reused between spot beam no. 1 and 6 and between spot 3 and 5.

The LLM channel G (4 MHz wide) is permanently connected to the Euroglobal beam, whereas each 1 MHz slot in the L1 and L2 frequency bands can be connected to each spot beam of the L-band coverage.

The LLM Payload is able to perform as EMS back-up system.

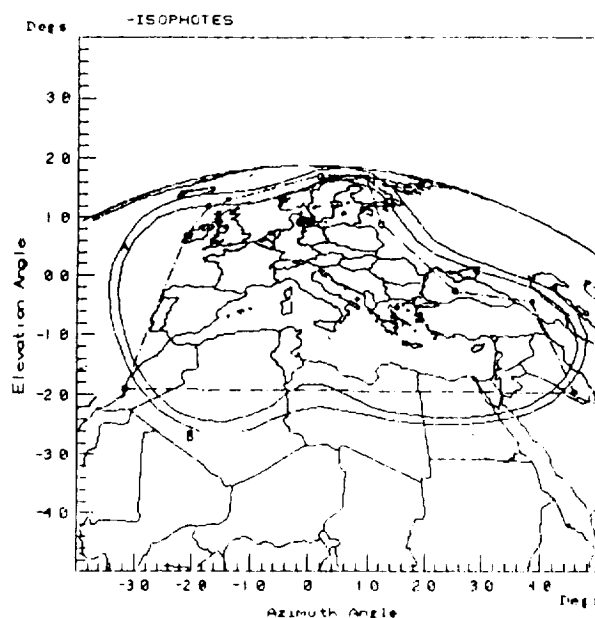


Fig. 3.1 LLM Payload Gain Contours (Euroglobal Coverage)

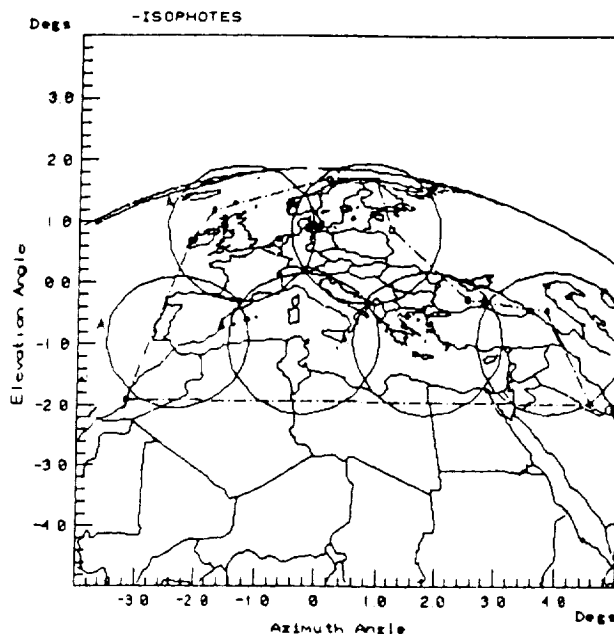


Fig. 3.2 LLM Payload Gain Contours (Beam Coverage)

#### 3.2 LLM Payload Block Diagram Description

The LLM Payload L-band Section is based on a large reflector, offset antenna with the following characteristics:

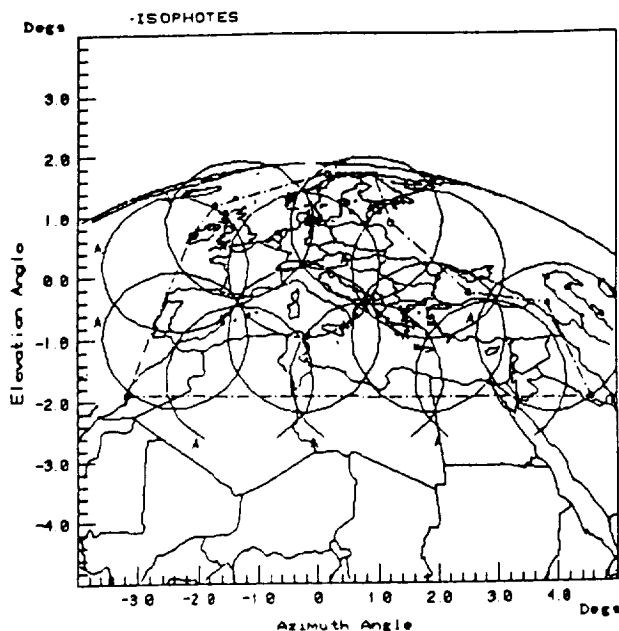


Fig. 3.3 LLM Payload Gain Contours (Steerable Beam)

- Projected Aperture 5 m
- F/D ratio 0.625
- Focal Length 3.125 m
- Clearance 0.71 m

The reflector is implemented by an inflatable structure manufactured by Contraves.

The L-band Feed Array is composed by 12 radiating elements, that are LH circular polarized except three of them that can provide both senses of circular polarization.

The Euroglobal Beam is generated by combining the signals from all of the twelve radiating elements, whereas the spot beams are synthesized by the signals from selected triplets of feed elements.

The correct phase distributions for the beams are generated in the Forward and Return Beam Forming Matrix.

The L-band High Power Section is formed by 12 dual-redundant SSPA's, of 10 W of output power each. The Power Amplifiers are arranged as 3 Multiport Amplifiers of order 4 x 4. This particular configuration has been defined by ESTEC and is patented as "Multimatrix Antenna".

One of its most important feature is that it allows to share the available RF power among the various beams in whichever ratio according to the traffic demand.

In the Return Link, each line from the Feed Array to the BFM is equipped with a dual-redundant LNA.

There are two IF Processors, one in the Forward and one in the Return Link.

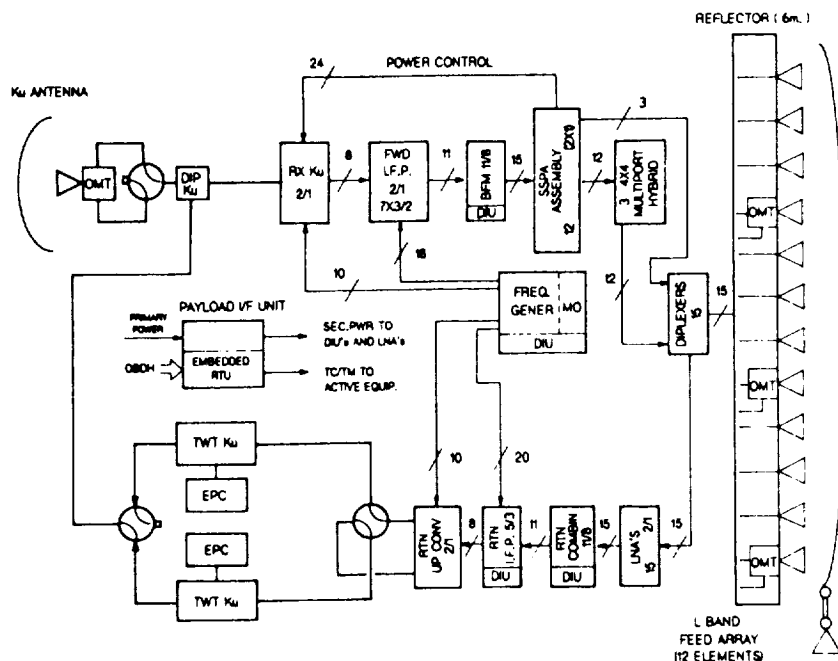


Fig. 3.4 LLM Payload Block Diagram

They perform channel filtering by using SAW filters and provide channel-to-beam switching function.

Each of them has a section dedicated to the EMS mode.

The frequency band of the Feeder Link of this Payload is at Ku-band, but the frequency allocation is not yet been defined. The Ku-band antenna is a 42 cm. onset parabola that can provide signals both in vertical and horizontal polarization.

The actual sense of polarization can be selected by ground command to cope with coordination requirement with other systems.

The received signals are LN amplified and down-converted by the Ku-band Receiver and then provided to the Forward IF Processor.

On the other side, the signals from the Return IF Processor are up-converted in the Return Upconverter.

The RF power at Ku-band is provided by a TWTA of 20W linear power that works at 6 dB back-off to cope with the linearity requirement.

#### 4. ECONOMICAL ASSESSMENT

The growth projections for mobile communications in Europe predict a potential market of 12 million users by 1995. At least an 8% of these can be served economically via satellite. To satisfy this demand the EMS payload should be available in orbit by 1993 providing some 400 channels.

The ITALSAT F2, scheduled for launch in the same time frame, is a convenient opportunity to embark the EMS payload

because of the minimum impact on ITS primary telecommunication mission [1].

In this respect the estimated cost of the space segment for the EMS mission is in the order of 10 to 13 million dollars per year while the potential revenue could be up to three times higher. The operator can take advantage of this opportunity considering also the possibility to have in orbit the LLM payload whose equivalent capacity could be leased for operational purposes. Financial risks should be agreed on the basis of the effective traffic carried out while preserving the technological content of the EMS and LLM missions which represent the forerunner of a dedicated commercial system.

#### CONCLUSIONS

Selenia Spazio has defined two payloads for Mobile Communications. The EMS Payload is a relatively "simple" payload in order to provide a pre-operational mobile communication service over Europe with limited risks within the required time frame (1993). The LLM Payload, through the experimentation of beam coverage at very high EIRP levels, intends to provide a field for development and testing of advanced technologies such as very large antennas, Beam Forming Matrices and Multiport Amplifiers that will be useful for future mobile communication payloads.

Both the systems have been demonstrated to be able to provide an adequate financial revenue.

Table 3.1 LLM Payload Performance Summary

EIRP	L-band Euroglobal	+45.9 dBW
	L-band Spot Beam	+51.4 dBW
	Ku-band Euroglobal	+38.3 dBW
G/T	L-band Euroglobal	+ 4.9 dB/K°
	L-band Spot Beam	- 1.2 dB/K°
	Ku-band Euroglobal	- 1.5 dB/K°
Coverage	See Fig. 3.1 and 3.2	
Linearity	L-band C/I > 16.1 dB	
(10 tone test)	Ku-band C/I > 21.1 dB	
P/L mass	140 kg.	
P/L Power Cons.	611 W	

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